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PATENT ABSTRACTS OF JAPAN

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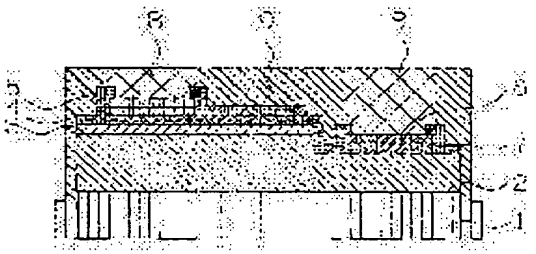
(54) LIGHT-EMITTING DEVICE AND FORMING METHOD THEREOF

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a conversion type light-emitting device together with its forming method of high reliability with good productivity, while excellent in optical characteristics.
SOLUTION: The light-emitting device is provided which comprises a light- emitting element where a semiconductor layer is provided on a substrate, a phosphor which absorbs a part of the light from the light-emitting element and emits a light of a wavelength longer than that, and a translucent mold member which comprises the phosphor and encloses the surface of the light- emitting element. At least one bump is provided on an electrode of the light- emitting element, with the upper surface of the bump almost flush with the upper surface of the translucent mold member.



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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the long wavelength conversion type luminescence equipment which has a semiconductor light emitting device and the fluorescent substance with which the light of long wavelength can emit light rather than it, and its formation method with respect to the luminescence equipment which can be used for a back light, the lighting light source, various indicators, a traffic light, etc. of liquid crystal.
[0002]
[Description of the Prior Art] The Light Emitting Diode chip using the nitride semiconductor (InxGayAl1-x-yN, 0<=x<=1, 0<=y<=1) which is the semiconductor light emitting device to which a blue glow can emit light in high brightness was developed today. The light emitting device using the nitride semiconductor has the inclination that it can be hard to obtain high power in the long wavelength field which has the wavelength more than green, the place by present, although an output is high as compared with the light emitting device which emits light in yellowish green from the red using material, such as other GaAs(es) and AlInGaP, and the color shift by temperature has the features, such as being few. On the other hand, a part of blue glow [at least] emitted from the Light Emitting Diode chip on this Light Emitting Diode chip was absorbed, and the light emitting diode to which a white system can emit light was developed by arranging the YAG:Ce fluorescent substance which is the fluorescent substance with which yellow can emit light. (International public presentation number WO 98/No. 5078)
[0003] This light emitting diode arranges a Light Emitting Diode chip at the pars basilaris ossis occipitalis in a cup of a mounting lead for example, and connects electrically the aforementioned Light Emitting Diode chip, the aforementioned mounting lead, and an inner lead by the gold streak etc. It is filled up with the translucency mould resin of the fluorescent substance content which emits light in the light of the yellow which absorbs a blue light from a Light Emitting Diode chip after connection and in the aforementioned cup, and has a complementary color relation. A convex lens is formed in a part for the point of both leads of the last by the resin of a translucency etc. Thus, the Light Emitting Diode lamp which emits light through a convex lens in a white light which consists of color mixture of the light of a Light Emitting Diode chip and a fluorescent substance is obtained.
[0004] The above-mentioned Light Emitting Diode lamp prepares the translucency mould resin of fluorescent substance content in the circumference of a chip beforehand, and forms a convex lens member with the resin of a translucency etc. after that. By this, when the light from a chip passes the translucency mould resin of the fluorescent substance content with which it filled up in the cup, it is a desired color mixture light. Therefore, the light by which color conversion was carried out can be taken out in the direction of a transverse plane good. Moreover, by adjusting the configuration of a cup, suppression of light scattering and improvement in a radiant power output can be aimed at, and a desired luminescence property can be acquired easily.
[0005]
[Problem(s) to be Solved by the Invention] However, such a Light Emitting Diode lamp was difficult for luminescence nonuniformity and chromaticity variation to be conspicuous and to produce with the sufficient yield as it was miniaturized.
[0006] Then, productivity is good and this invention aims to let it offer the long wavelength conversion type luminescence equipment and its formation method of the chip type which was excellent in the optical property.

[0007]
[Means for Solving the Problem] Namely, the light emitting device to which the luminescence equipment concerning this invention has a semiconductor layer on a substrate, A part of light from this light emitting device is absorbed. The fluorescent substance with which the light of long wavelength can emit light rather than it, the luminescence equipment which has the translucency mould member which has this fluorescent substance and surrounds the front face of the aforementioned light emitting device -- it is -- the electrode top of the aforementioned light emitting device -- at least one bump -- having -- this bump's upper surface -- the aforementioned translucency mould -- it is characterized by being the upper surface and the abbreviation same flat surface of a member It is reliable and the luminescence equipment which can emit light uniformly in a desired color mixture light is obtained by this.
[0008] Moreover, the aforementioned bump's thickness is 5 micrometers - 150 micrometers. The luminescence equipment which can emit light to high power is obtained by this.
[0009] moreover, the aforementioned bump's upper surface and the aforementioned translucency mould -- the upper surface of the luminescence equipment which consists of the upper surface of a member is characterized by being abbreviation parallel to a substrate side base The luminescence equipment which has good directional characteristics is obtained by this.
[0010] Moreover, a fluorescent substance is characterized by being one sort chosen from nitrogen content CaO-aluminum2O3-SiO2 activated by the yttrium aluminum garnet system fluorescent substance activated by Ce, Eu, and/or Cr. Luminescence equipment with the high reliability in which color mixture luminescence in high brightness is simple and possible is obtained by this.
[0011] Moreover, it is characterized by having the reflective film of the aforementioned light emitting device which followed the substrate side at least. The few luminescence equipment of brightness nonuniformity with good and luminous efficiency is obtained by this.
[0012] Moreover, the light emitting device to which the formation method of the luminescence equipment concerning this invention has a semiconductor layer on a substrate, A part of light from this light emitting device is absorbed. The fluorescent substance with which the light of long wavelength can emit light rather than it, The 1st process which is the formation method of luminescence equipment of having the translucency mould member which has this fluorescent substance and surrounds the front face of the aforementioned light emitting device, and forms a bump on the electrode of the aforementioned light emitting device in the state of a wafer, The 2nd process which makes the material which serves as the aforementioned translucency mould member so that the aforementioned bump may be covered to the semiconductor layer side of the aforementioned light emitting device cover, After stiffening the material used as the aforementioned translucency mould member, it has the 3rd process which exposes a bump's upper surface to the aforementioned wafer base and parallel from a semiconductor layer side by polish, and the 4th process which cuts the aforementioned wafer dicing and by carrying out a scribe. Luminescence equipment can be formed with sufficient mass-production nature by this.
[0013] Moreover, in the 3rd process of the above, it is ground so that each aforementioned bump's thickness may be set to 5 micrometers - 150 micrometers. the mould formed at the 2nd process of the above of this -- a member -- it can grind good, without destroying an inner fluorescent substance, and luminescence equipment with reliability able to emit light uniformly highly is obtained
[0014] Moreover, it is characterized by forming the translucency mould member of the aforementioned light emitting device which followed the substrate side at least after the process of the above 4th. The luminescence equipment obtained by this can have the translucency mould member of fluorescent substance content on the whole periphery surfaces other than the bump upper surface electrically joined to an external electrode, and the reliable and high luminescence equipment of color purity is obtained.
[0015] Moreover, it is characterized by forming the reflective film of the aforementioned light emitting device which followed the substrate side at least after the process of the above 4th. The light emitted from the substrate side of a light emitting device can be led to a semiconductor layer side, and the high luminescence equipment of a radiant power output with still less [and] color nonuniformity is obtained by this.
[0016]
[Embodiments of the Invention] Variously, as a result of the experiment, before this invention person connected the element electrically, by preparing the translucency mould member of the fluorescent substance content which is color transducer material, he finds out that can simplify a next mounting

process and reliable color conversion type luminescence equipment is obtained, and came to accomplish this invention.
[0017] When a wavelength conversion type Light Emitting Diode lamp was formed conventionally, apart from the convex lens member, the mould member of fluorescent substance content needed to be beforehand prepared to each element by which element division was carried out. Specifically, the following process is needed.
[0018] First, after arranging at the bottom in a cup of a mounting lead of each element of the letter of a chip and connecting each electrode of the aforementioned element with a lead electrode electrically with a wire etc., in a cup, dropping pouring is carried out, heat hardening of the resin which made the fluorescent substance contain by the dispenser etc. is carried out, and color transducer material is formed so that an element and a wire may be covered. It does in this way and the 1st mould member is formed.
[0019] then, a convex lens -- while slushing the resin which is the material of a member in a casting case, immersing arrangement of the part for the lead point in which color transducer material was formed is carried out By putting in and carrying out heat hardening of this to oven, the convex lens member which is a member the 2nd mould is formed, and the Light Emitting Diode lamp in which wavelength conversion is possible is formed.
[0020] Thus, in forming one luminescence equipment, the process which is made filled up with a resin to each element, and is stiffened is twice needed, the **** time for the resin effect is comparatively long, and improvement in the further productivity is desired.
[0021] moreover -- as luminescence equipment is miniaturized -- inevitable -- the 1st mould -- a member -- it was very difficult to arrange the amount of fluorescent substances required in order to become little [an amount] and to obtain a desired color mixture light with a sufficient precision to each element, and chromaticity variation arose in each luminescence equipment, and the yield was bad
[0022] Moreover, it has a wire etc. in the aforementioned color transducer material in order to prepare color transducer material, after the aforementioned luminescence equipment connects a semiconductor layer for a light emitting device electrically as the upper surface. Such electric-lines-or-cable material has a bad influence on arrangement of a fluorescent substance, or reduces the aforementioned fluorescent substance and the optical ejection efficiency of a light emitting device, and is considered to cause color nonuniformity and loss of power.
[0023] Then, this invention prepares color transducer material in the light emitting device itself in order to solve the above-mentioned problem. Piling of the electrode section of the aforementioned light emitting device is specifically carried out in the state of the wafer before being divided into each light emitting device, and color transducer material is prepared in the circumference of a light emitting device. Thus, by constituting, reliability can fully form the color conversion type luminescence equipment which was highly excellent in the optical property with sufficient productivity.
[0024] The form of the operation which makes drawing reference and relates to this invention hereafter is explained. Drawing 1 is the typical cross section of the light emitting diode concerning the form of 1 operation of this invention. Laminating formation of n type nitride semiconductor layer 2, a barrier layer (not shown), and the p type nitride semiconductor layer 3 is carried out in order at least insulating substrate top 1. The 1st transparent positive electrode 4 of p type nitride semiconductor layer 3 mostly formed in the whole surface, The 2nd positive electrode 5 for bondings formed in the part on the 1st positive electrode 4, It has a negative electrode 6 on n type nitride semiconductor layer 2 exposed by etching etc. from p type nitride semiconductor layer 3 side, and the light emitting device in which it comes to form the insulating protective coat 7 except for the bonding side of each electrode is used. a bump 8 is formed on the bonding side of each electrode of such a light emitting device, respectively, and these bumps' upper surface is exposed -- making -- the translucency mould of fluorescent substance content on the semiconductor layer side upper surface and the side of a light emitting device -- the member 9 is formed Hereafter, each composition of this invention is explained in full detail.
[0025] (Light emitting device) In this invention, the light from a light emitting device is more efficient than the light emitted from a fluorescent substance in it being short wavelength. Therefore, what used the nitride semiconductor (InxGayAl1-x-yN, 0<=x<=1, 0<=y<=1) for the barrier layer is suitably mentioned by making the light with luminescence brightness high efficient into the semiconductor device which can emit light. Although the light emitting device using the nitride semiconductor can be made to form on silicon on sapphire, a spinel (MgAi 2O4) substrate, SiC, a GaN single crystal, etc., it is desirable to use silicon on

sapphire for fulfilling mass-production nature and crystallinity. Therefore, in this invention, it is formed on the silicon on sapphire n type and whose p type nitride semiconductor layer are insulating substrates, and the light emitting device which has two electrodes in a semiconductor layer side is used.
[0026] If it furthermore explains to a detail, the laminating of the p type nitride semiconductor layer 3 which a light emitting device becomes from n type nitride semiconductor layer 2 which consists of 1 or two or more layers on silicon on sapphire 1, a barrier layer (not shown), 1, or two or more layers is carried out, and the further positive and negative electrode is formed as follows. That is, a positive electrode consists of the 2nd positive electrode 5 for bondings formed in the part on the 1st positive electrode 4 of p type nitride semiconductor layer mostly formed in the whole surface, and this 1st positive electrode, and the negative electrode 6 is formed in the front face of n type nitride semiconductor layer which removed a part of p type nitride semiconductor layer by dry etching etc., and was exposed.
[0027] In this invention, n type nitride semiconductor layer 2 and especially p type nitride semiconductor layer 3 are not limited, but may use the thing of which lamination.
[0028] When making a white system emit light in the luminescence equipment of this invention, in consideration of a complementary color relation with a fluorescent substance, degradation of a resin, etc., the main luminescence peak of a light emitting device has 400nm or more desirable 530nm or less, and it is 420nm or more 490nm or less more preferably. In order to raise the efficiency of a light emitting device and a fluorescent substance, respectively, it is still more desirable to use for 450nm or more 470nm or less the light emitting device which has the main luminescence peak.
[0029] On the other hand, when it has the translucency mould member of fluorescent substance content around a light emitting device in the luminescence equipment of this invention, a resin, glass, etc. comparatively strong against ultraviolet rays can be used, and the luminescence equipment with which a white system can emit light can also be obtained using the light emitting device to which the ultraviolet rays which make the short wavelength near 400nm the main luminescence peak can emit light. The white light can be acquired by the light of such short wavelength red, blue, and by containing in Sr5(PO4) 3 Cl:Eu as Y2O2 S:Eu and a blue fluorescent substance, making the aforementioned ultraviolet-rays-proof resin etc. contain O-aluminum 2O3 as a green fluorescent substance (SrEu) green as the fluorescent substance in which fluorescence is possible, for example, a red fluorescent substance, and applying to the front face of the light emitting device of short wavelength luminescence as a color conversion layer.
[0030] With the form of 1 operation of this invention, it has the translucency mould member which is a color conversion layer around [all] the aforementioned light emitting device by using as opening the front face of the bump stationed on the electrode of a light emitting device. The light which emits light from all directions of the aforementioned light emitting device by this is efficiently absorbed with the fluorescent substance arranged around, and after wavelength conversion is carried out, it is emitted. For this reason, reliable white system luminescence equipment is obtained, without luminescence equipment deteriorating by ultraviolet rays.
[0031] moreover, in order to acquire the white light, as a fluorescent substance used combining the light emitting device to which ultraviolet rays can emit light Described above and also as a red fluorescent substance 3.5MgO, 0.5MgF2, and GeO2:Mn, Re5(PO4) 3 Cl:Eu (however, Re is chosen from Sr, calcium, Ba, and Mg at least a kind), BaMg2aluminum16O27:Eu, etc. are suitably used as Mg6As2O11:Mn, Gd2O2:Eu, LaO2 S:Eu, and a blue fluorescent substance. Since luminescence by ultraviolet radiation is excellent by leaps and bounds, these fluorescent substances can obtain the white luminescence equipment which can emit light in high brightness.
[0032] It will not be limited especially if the 1st positive electrode 4 is an electrode material in which p type nitride semiconductor layer and ohmic contact are possible in this invention. For example, one or more kinds, such as Au, Pt, aluminum, Sn, Cr, Ti, nickel, and Co, can be used. Moreover, by this invention, although it can adjust to a translucency and a non-translucency because the 1st positive electrode adjusts thickness according to a mounting form, the 1st positive electrode is adjusting thickness so that it may become a translucency. In order to become a translucency, 10A - 500A of thickness is preferably set as 10A - 200A.
[0033] Moreover, as the 2nd positive electrode 5, one or more kinds of metallic materials, such as Au, Pt, aluminum, Sn, Cr, Ti, and nickel, can be used. As for the thickness of the 2nd positive electrode, it is desirable to be set as 1000A - 2 micrometers.
[0034] It will not be limited especially if a negative electrode 6 is an electrode material in which n type

nitride semiconductor and ohmic contact are possible in this invention. For example, although one or more kinds of metallic materials, such as Ti, aluminum, nickel, Au, W, and V, can be used, it is desirable to consider as multilayer structure which uses Ti, W, and V as the base, respectively, such as Ti/aluminum, W/aluminum/W/Au, W/aluminum/W/Pt/Au, and V/aluminum. Vf can be reduced by using the electrode material in which n type nitride semiconductor layer and ohmic contact are possible. 2000A - 5 micrometers of thickness of a negative electrode 7 are preferably set as 5000A - 1.5 micrometers.
[0035] In this invention, in order to prevent the inter-electrode short circuit of positive/negative, it is desirable to form the insulating protective coat 7 in the front face of a semiconductor layer by using the bump forming face of each electrode as opening. Moreover, when an insulating protective coat is formed so that the upper surface of each electrode may be started for a while, it can suppress peeling with the ground layer with which each electrode is in contact, and is desirable. It will not be limited, especially if permeability is good in the dominant wavelength as a material of an insulating protective coat and the adhesive property with the 1st positive electrode, the 2nd positive electrode, and a negative electrode is good. Moreover, it is desirable when the material which cuts the light of a short wavelength field is used. For example, the oxide of glass constituents, such as silicic-acid alkali glass, a soda lime glass, lead glass, and barium glass, or SiO2, TiO2 and GeO2, and Ta2O5 grade is formed preferably. Moreover, although especially thickness is not limited, it is desirable that the permeability in the dominant wavelength is adjusted to 90% or more.
[0036] (Bump) the translucency mould by which a light emitting device has at least one bump on an electrode, and this bump's upper surface has been arranged in contact with the aforementioned bump's side in this invention -- it is the upper surface and the abbreviation same flat surface of a member thus, a bump's upper surface and a translucency mould -- reliable luminescence equipment with easy and mounting is obtained by constituting an abbreviation same flat surface from the upper surface of a member
[0037] The aforementioned bump is formed on the bonding side of the electrode of each element in the wafer state before a light emitting device is cut separately first (the 1st process). A bump's material can obtain the bump excellent in adhesion with each electrode, and conductivity, if metallic materials, such as Au and Pt, are used. Sticking-by-pressure formation of the aforementioned metallic material is carried out on each aforementioned bonding side in a bump bonder. If flattening of the part for the height produced in a part for the central point on the upper surface of a bump is pressed and carried out in a leveler, the bump who has width of face almost equal to an upper surface side from a base side can be formed. Moreover, the configuration of a bump's side can be adjusted by adjusting the aforementioned press. a bump's side is a taper configuration -- desirable -- a translucency mould -- a member -- the ejection efficiency of light can be raised by carrying out reflective dispersion of the light which emits light from an inner fluorescent substance and an inner light emitting device good on the aforementioned side
[0038] As for a bump, in the case of the aforementioned metallic material, it is desirable to form in a height of 20-50 micrometers. Moreover, it is also possible to form a bump in a thick film using material, such as plating. For example, it can form in a height of 5-150 micrometers by non-electrolyzed nickel plating. Moreover, a bump can also be made the two-layer composition which prepared non-electrolyzed Au plating on non-electrolyzed nickel plating. For example, bonding nature becomes good and is desirable, when non-electrolyzed nickel plating is formed in a height of 5-100 micrometers and non-electrolyzed Au plating is formed in a height of 5000A or less on the aforementioned radio solution nickel plating. thus, the translucency mould member of fluorescent substance content in the semiconductor layer side of the element in which the bump was formed -- preparing (the 2nd process) -- the particle size of a fluorescent substance -- thinking -- the aforementioned translucency mould -- a member -- so that the upper surface and the aforementioned bump's upper surface may accomplish an abbreviation same flat surface Moreover, preferably, the whole bump's thickness grinds the aforementioned translucency mould member and the aforementioned bump simultaneously, and exposes 5 micrometers - 100 micrometers of 5 micrometers - 150 micrometers of a bump's front faces so that it may be more preferably set to 50 micrometers - 100 micrometers (the 3rd process). Thus, by making a bump's height into the aforementioned range, color tone nonuniformity is suppressed and the luminescence equipment which has a good optical property is obtained.
[0039] Moreover, in the case of the light emitting device which has the electrode of a positive/negative couple and emits light in the light to the same side side like the light emitting device used with the gestalt of this operation, the current density near a negative electrode becomes high, and it is in the inclination

which color nonuniformity produces. the translucency mould whose upper surface of this bump a bump is prepared on each electrode of the aforementioned light emitting device in this invention, and is an optical ejection side -- a member -- the color nonuniformity produced in each inter-electrode one by constituting can be improved so that it may become the upper surface and an abbreviation same flat surface, and the luminescence equipment which can emit light uniformly is obtained

[0040] (Fluorescent substance) The fluorescent substance used for the luminescence equipment of this invention uses as the base the yttrium aluminum oxide system fluorescent substance activated with the cerium which is made to excite the light which emitted light from the semiconductor light emitting device which makes a nitride system semiconductor a luminous layer, and can emit light. As a concrete yttrium aluminum oxide system fluorescent substance, YAlO3:Ce, Y3aluminum5O12 Y:Ce (YAG:Ce) and Y4aluminum2O9:Ce(s), such mixture, etc. are mentioned. Even if an yttrium aluminum oxide system fluorescent substance has little Ba, Sr, Mg, calcium, and Zn, a kind may contain in it. Moreover, by making Si contain, the reaction of a crystal growth can be suppressed and the particle of a fluorescent substance can be arranged.

[0041] In this specification, especially the yttrium aluminum oxide system fluorescent substance activated by Ce shall be interpreted in a wide sense. It is replaced by at least one element chosen from the group which consists of Lu, Sc, La, Gd, and Sm in a part or the whole of an yttrium. or a part or the whole of aluminum -- any of Ba, Tl, Ga, and In -- or it is used for the latus meaning containing the fluorescent substance which is replaced in great numbers and has a fluorescence operation

[0042] In detail Furthermore, general formula (YzGd1-z) 3aluminum5O12:Ce The photoluminescence fluorescent substance shown by (0< z<=1 [however,]), and general formula (Re1-aSma) 3Re'5O12:Ce (however, 0<=a<1, 0<=b<=1, and Re) it is chosen from Y, Gd, La, and Sc -- a kind and Re' at least are chosen from aluminum, Ga, and In -- it is a kind at least It is the photoluminescence fluorescent substance shown.

[0043] This fluorescent substance can be strong for heat, light, and moisture, and can make the peak of an excitation spectrum carry out near 450nm for garnet structure. Moreover, it has the broadcloth emission spectrum to which a luminescence peak is also near 580nm and lengthens the skirt to 700nm.

[0044] Moreover, a photo-luminescence fluorescent substance can make high excitation luminous efficiency of a long wavelength region 460nm or more by containing Gd (gadolinium) during a crystal. By the increase in the content of Gd, an emission peak wavelength moves to long wavelength, and also shifts the whole luminescence wavelength to a long wavelength side. That is, when the strong luminescent color of redness is required, the amount of substitution of Gd can be attained by making [many] it. On the other hand, while Gd increases, the luminescence brightness of photo luminescence by the blue glow tends to fall. Furthermore, Tb, Cu, Ag, Au, Fe, Cr, Nd, Dy, Co, nickel, Ti, Eu and others can also be made to contain according to a request in addition to Ce.

[0045] And luminescence wavelength shifts a part of aluminum to a short wavelength side in replacing by Ga among composition of an yttrium aluminum garnet system fluorescent substance with garnet structure. Moreover, luminescence wavelength shifts a part of Y of composition to a long wavelength side in replacing by Gd.

[0046] When replacing a part of Y by Gd, it is desirable to carry out substitution to Gd to less than ten percent, and to set content (substitution) of Ce to 1.0 from 0.03. Although a green component is large and the substitution of a red component to Gd decreases at the less than twenty percent, a red component is suppliable with increasing the content of Ce, and a desired color tone can be acquired, without reducing brightness. If it is made such composition, the temperature characteristic can become good and can raise the reliability of light emitting diode. Moreover, if the photo-luminescence fluorescent substance adjusted so that it might have many red components is used, the luminescence equipment which can emit light in neutral colors, such as pink, can be formed.

[0047] An oxide or the compound which turns into an oxide easily at an elevated temperature is used for such a photo-luminescence fluorescent substance as a raw material of Y, Gd, aluminum, and Ce, it fully mixes them by the stoichiometry, and obtains a raw material. Or the coprecipitation oxide which calcinates what coprecipitated the solution which dissolved the rare earth elements of Y, Gd, and Ce in the acid by the stoichiometry with oxalic acid, and is obtained, and an aluminum oxide are mixed, and a mixed raw material is obtained. It can obtain by carrying out proper quantity mixture of the fluorides, such as barium fluoride and an ammonium fluoride, as flux at this, stuffing a crucible, calcinating by the temperature

requirement of 1350-1450 degreein air C for 2 to 5 hours, obtaining a burned product, carrying out the ball mill of the burned product underwater next, and letting a screen pass at washing, separation, dryness, and the last.

[0048] In the light emitting diode of the invention in this application, such a photo-luminescence fluorescent substance may mix the yttrium aluminum garnet fluorescent substance and other fluorescent substances which were activated with two or more kinds of ceriums.

[0049] Nitrogen content calcium-aluminum2O3-SiO2 fluorescent substance (oxy-night RAIDO fluorescence glass) activated by the sapphire (aluminum oxide) fluorescent substance which otherwise absorbed blue, a bluish green color, and green, and was activated by Eu and/or Cr as a fluorescent substance with which red can emit light, Eu, and/or Cr is mentioned. The white light can also be acquired using these fluorescent substances by the color mixture of the light from a light emitting device, and the light from a fluorescent substance.

[0050] moreover, the translucency mould which a fluorescent substance contains -- the viscosity of a member and the particle size of a fluorescent substance influence the mass-production nature at the time of formation That is, when the viscosity of the material used as a translucency mould member is low, or when the particle size of a fluorescent substance is large, it is in the inclination which separation sedimentation by the specific gravity difference with the material used as a translucency mould member promotes. Moreover, it is in the inclination for a conversion efficiency to fall by crystal destruction at a pulverization process etc. if particle size becomes small in an inorganic fluorescent substance. since [furthermore,] a floc is constituted if it becomes not much small too much -- a translucency mould -- a member -- it is in the inclination which the dispersibility to inside falls and causes the color nonuniformity and brightness nonuniformity from luminescence equipment therefore, a translucency mould -- although based also on the material and the fluorescent substance of a member, the mean particle diameter of a fluorescent substance has desirable 1-100 micrometers, and its 5-50 micrometers are more desirable A mean particle diameter shows the mean particle diameter measured in the subsieve sizer by making an air permeability method into a basic principle here.

[0051] Moreover, in order to raise a radiant power output, the mean particle diameter of the fluorescent substance used by this invention has 10 micrometers - desirable 50 micrometers, and it is 15 micrometers - 30 micrometers more preferably. For the fluorescent substance which has such a particle size, the rate of the absorption of light and a conversion efficiency are high, and the width of face of excitation wavelength is latus. Thus, by making the diameter fluorescent substance of a large drop which has the optically excellent feature contain, it becomes possible to also change the light of the dominant-wavelength circumference of a light emitting device good, and to emit light, and the mass-production nature of luminescence equipment improves.

[0052] moreover, the fluorescent substance which has this mean-particle-diameter value -- frequency -- containing highly is desirable and 20% - 50% of a frequency value is desirable Thus, the luminescence equipment which color nonuniformity is suppressed and has a good color tone is obtained by using a fluorescent substance with the small variation in particle size.

[0053] As a concrete fluorescent substance used for this invention, the YAG system fluorescent substance (garnet system fluorescent substance activated with the cerium which comes to contain at least one element chosen from Y, Lu, Sc, La, Gd, and Sm and at least one element chosen from the group which consists of aluminum, Ga, and In) activated by Ce is mentioned. A YAG system fluorescent substance makes the solution which dissolved the rare earth elements of Y, Gd, and Ce in the acid by the stoichiometry sediment with oxalic acid. The coprecipitation oxide and aluminum oxide which calcinate this and are obtained are mixed, and a mixed raw material is obtained. An ammonium fluoride is mixed as flux to this, a crucible is stuffed, it calcinates at the temperature of 1400 degrees C among air for 170 minutes, and a burned product is obtained. The ball mill of the burned product can be carried out underwater, and a YAG system fluorescent substance can be made to form in washing, separation, dryness, and the last through a screen.

[0054] Similarly, nitrogen content CaO-aluminum2O3-SiO2 fluorescent substance activated by Eu and/or Cr is mentioned as other concrete fluorescent substances used for this invention. Nitrogen content CaO-aluminum2O3-SiO2 fluorescent substance activated by this Eu and/or Cr makes raw materials, such as an aluminum oxide, a yttrium oxide, a silicon nitride, and a calcium oxide, fuse and fabricate the powder which mixed the rare earth raw material to the predetermined ratio in 1300 degrees C to 1900 degrees C

(from 1500 degrees C to 1750 degrees C [Preferably]) in the bottom of nitrogen-gas-atmosphere mind. The ball mill of the mold goods can be carried out, and a fluorescent substance can be made to form in washing, separation, dryness, and the last through a screen. It can consider as the calcium-aluminum-Si-O-N system oxy-night RAIDO fluorescence glass activated by Eu to which red luminescence can emit light, and/or Cr by the excitation spectrum which had a peak in 450nm by this, and the blue glow which has a peak in about 650nm.

[0055] In addition, the peak of an emission spectrum can be continuously shifted from 575nm to 690nm by fluctuating the nitrogen content of the calcium-aluminum-Si-O-N system oxy-night RAIDO fluorescence glass activated by Eu and/or Cr. Similarly, an excitation spectrum can also be shifted continuously. Therefore, a white system can be made to emit light by the synthetic light of the light from the gallium-nitride system compound semiconductor which contains in a luminous layer GaN by which impurities, such as Mg and Zn, were doped, and InGaN, and the light of about 580nm fluorescent substance. Especially, about 490nm light can also obtain luminescence ideal for combination with the light emitting device which consists of a gallium-nitride system compound semiconductor which contains in a luminous layer InGaN which can emit light in high brightness.

[0056] Moreover, the light emitting diode with very high color rendering properties which contains a RGB (red, green, blue) component in high brightness using the light emitting device to which a blue system can emit light can also be made to form by combining the nitrogen content calcium-aluminum-Si-O-N system oxy-night RAIDO fluorescence glass activated by the YAG system fluorescent substance activated by above-mentioned Ce, Eu, and/or Cr. For this reason, arbitrary neutral colors can also be made to form very simply only by adding a desired pigment. Any fluorescent substance is an inorganic fluorescent substance, and can make the light emitting diode in which the outstanding mass-production nature was compatible with high contrast form in this invention using an organic light-scattering agent, organic SiO2, etc.

[0057] (Translucency mould member) A translucency mould member is made to contain such a fluorescent substance. a translucency mould -- as a material of a member, lightfastness is high to a light emitting device and the light from a fluorescent substance, and the thing excellent in the translucency is desirable Moreover, when working as a protective coat which covers a light emitting device, a certain amount of rigidity is required. a translucency mould -- non-solvents, such as an epoxy resin, silicone resin, a urethane resin, an unsaturated polyester resin, an acrylic urethane resin, and polyimide resin, or a solvent type liquefied translucency heat-curing resin is specifically suitably mentioned as a material of a member Similarly, a liquefied translucency thermoplastic resin solvent type [, such as acrylic resin, polycarbonate resin, and a poly norbornene resin,] can also be used. Furthermore, not only the organic substance but the hybrid resin which mixed a silicon dioxide, acrylic resin, etc. which were formed with inorganic substances and sol-gel methods, such as a silicon dioxide, can be used suitably. moreover, a convex lens -- the cases where a translucency mould member is further covered with a resin etc., such as a member, -- a convex lens -- selection use can be carried out from the resin indicated by **** in consideration of adhesion with a member etc.

[0058] this invention -- setting -- the translucency mould of fluorescent substance content -- a member 9 is formed in the upper surface and the side of an element of a wafer state Thus, by carrying out in the state of a wafer, it can grind behind, and can adjust to desirable thickness, and the luminescence equipment which has an ideal color tone can be formed. Moreover, by preparing so that it may cover to the side of an element, the translucency mould member of the aforementioned fluorescent substance content can carry out color conversion of the light from the element side, can be emitted, and can suppress color tone nonuniformity. moreover, the light emitting diode of this invention -- the translucency mould of fluorescent substance content -- a member -- since a thing required to connect electrically, such as a wire, does not exist in inside, there is nothing that intercepts light and optical ejection efficiency is good

[0059] the translucency mould which serves as a luminescence side in this invention -- the upper surface of a member is a bump's upper surface and abbreviation same flat surface on the electrode of a light emitting device Here, in this specification, it considers as the thing of a wide sense with an abbreviation same flat surface that the coat of the aforementioned bump's whole side should just be carried out by the aforementioned translucency mould resin. Thus, without exposing a bump's side, by covering with the aforementioned translucency mould member, it can prevent that moisture will be absorbed from the interface of the aforementioned bump and the aforementioned translucency mould member, and is desirable. moreover, the aforementioned mould -- especially the configuration of the upper surface of a

member is not limited, and may wear the curve, you may have irregularity, in such composition, the lens effect is acquired, and good directional characteristics are acquired
[0060] thus, the obtained luminescence equipment -- a bump's 8 upper surface, and the translucency mould of fluorescent substance content -- the upper surface of the luminescence equipment which consists of a member 9, and the substrate side base of luminescence equipment attain [various mounting] with their being abbreviation parallel and are desirable Furthermore, the aforementioned luminescence equipment can mount two or more luminescence equipments densely easily as it is an abbreviation rectangular parallelepiped, and it is desirable. In case an external electrode and luminescence equipments, such as a lead electrode, are taken because prepare a bump on each aforementioned electrode, respectively and the conductive connection portion of the electrode of each positive/negative considers as equal height mutually from an element base side when using for the same field side especially the light emitting device which has two electrodes, and electric conduction is taken with a wire, the loop shape and angle of approach of each wire can be made equal. The intensity of a wire can improve by this and the wire piece by external force etc. can be prevented.
[0061] Furthermore, as shown in drawing 5 , you may prepare in all directions so that the circumference of the aforementioned light emitting device may be covered by using as opening a bump's upper surface in which the translucency mould member of the aforementioned fluorescent substance content was prepared on each electrode of a light emitting device. Thus, if constituted, all the light that emits light from a light emitting device can be changed good, and the luminescence equipment which can emit light uniformly is obtained. If the translucency mould member of fluorescent substance content is especially prepared also in a substrate side base, flip mounting is attained and improvement in an output can be aimed at. On the other hand, when the substrate side of the aforementioned luminescence equipment is made to counter a mounting substrate and it fixes by the die bond resin, the light which emits light from the substrate base side of a light emitting device by making the aforementioned fluorescent substance contain in the aforementioned die bond resin can be changed good, and it can take out outside.
[0062] (Reflective film) The reflective film 11 used for this invention is for suppressing that the light which emits light from a substrate side is emitted outside, raising optical ejection efficiency, and obtaining better luminescence. As a material of a desirable reflective film, an oxide film, various metals, etc. which were formed by the multilayer are mentioned. It is desirable to use a metal membrane from a viewpoint of the plain-gauze fibers for plastering of formation especially. As a metal membrane, high Ag, aluminum, those alloys, etc. of a reflection factor are specifically mentioned. These metal membranes can be formed by the sputtering method, the vacuum deposition method, etc. In this invention, that what is necessary is to just be formed so that the base of a substrate may be worn at least, a reflective film is continuously formed so that the side and the base of a chip may be worn preferably.
[0063]
[Example] Hereafter, the light emitting diode of the example concerning this invention is explained. In addition, this invention is not limited only to the example shown below.
[0064] The luminous layer (not shown) to which each semiconductor layers 2 and 3 and blue (470nm) can emit light is formed by the MOVPE method on the insulating substrate 1 which consists of [example 1] sapphire (Cth page). A wafer is picked out from a reaction container after annealing, after forming the insulator layer which becomes the front face of p type nitride semiconductor layer of the best layer from predetermined SiO2 grade, the resist film of a predetermined configuration is formed on the aforementioned insulator layer front face, RIE (reactive ion etching) equipment performs etching from p type nitride semiconductor layer side, and the front face of n type nitride semiconductor layer which forms a negative electrode is exposed. Next, after exfoliating the aforementioned insulator layer with an acid, the 1st positive electrode 4 on p type nitride semiconductor layer in the best layer which becomes the whole surface from nickel/Au mostly is formed by 200A of thickness so that a light transmittance with a wavelength of 470nm may be 40% and surface resistivity may become 2ohms / **. Next, the 2nd positive electrode 5 which consists of Au by the lift-off method is formed by 0.7 micrometers of thickness on the 1st positive electrode of the above. On the other hand, the negative electrode 6 which similarly consists of W/aluminum/W/Au by the lift-off method is formed in the front face of n type nitride semiconductor layer exposed by etching by 0.8 micrometers of thickness, and it considers as a Light Emitting Diode element.
[0065] Next, the insulating protective coat 7 which consists of SiO2 so that only the bonding area of each electrode may be exposed and the whole element may be covered by patterning is formed by 2

micrometers of thickness so that a light transmittance may become 90% in the wavelength of 470nm.
[0066] It sets to the nitride semiconductor wafer which it is above and which was formed by having, and is drawing 3 . - As shown in (a), the crevice for preparing the translucency mould member of fluorescent substance content in the semiconductor layer side by dicing is formed. Thus, by carrying out dicing, the translucency mould member of fluorescent substance content can be arranged on the side of the luminous layer of a light emitting device, color nonuniformity can be suppressed, and it is desirable. Moreover, in case the scribe of the wafer is carried out, the pressure concerning this wafer can be reduced and the curvature and cleavage of a substrate can be suppressed. Au which is a bump's 8 material is made to stick by pressure in a height of 50 micrometers in bump BOMBA on each bonding side of each electrode after dicing. (The 1st process) .
[0067] on the other hand, SiO2 is fully stirred for 3aluminum5O12:Ce at 65 degrees C as a fluorescent substance (Y0.8Gd0.2) as 80 weight sections, the epoxy resin 100 weight section, an acid anhydride, a hardening accelerator, and a dispersing agent -- making -- the translucency mould of fluorescent substance content -- the material used as a member 9 is formed The viscosity of the epoxy resin at this time is 700cp (s). Thus, the material used as the translucency mould member of the formed fluorescent substance content is made to cover with 150 micrometers of thickness so that the aforementioned bump may be covered by DIP (the 2nd process). This is stiffened by primary 85-degree-C hardening for 180 minutes, and 140-degree-C secondary hardening for 240 minutes.
[0068] next, this translucency mould from the luminescence side of a light emitting device -- a member -- the upper surface is set to 40 micrometers -- as -- each bump 8 and the translucency mould of fluorescent substance content -- a member 9 is ground from both semiconductor layer sides, and a bump's 8 front face is exposed (the 3rd process) Moreover, the grinding and polish of a substrate are done from a substrate side so that it may be thin to 120 micrometers.
[0069] After dicing finally removes the translucency mould member of a position from which a nitride semiconductor wafer is cut, a scribe line is lengthened with a scriber and external force cuts in the shape of [of 300 micrometer angle] a chip (the 4th process).
[0070] The yield is 95% when a white Light Emitting Diode lamp is formed using the light emitting diode formed as mentioned above. Thus, by using the light emitting diode which is this invention, luminescence equipment can be produced with sufficient mass-production nature, and reliability can offer the few high and luminescence equipment of color tone nonuniformity.
[0071] On the other hand, after preparing an insulator layer, a nitride semiconductor layer semiconductor wafer is cut in the shape of a chip. (Example 1 of comparison) After arranging on the base in a cup of a mounting lead of each light emitting device and connecting electrically with a wire The yield is 85% when light emitting diode is formed like an example 1 except making it first filled up with a fluorescent substance content translucency mould member in a cup so that a light emitting device may be covered, and preparing the convex lens member of a translucency after that. Moreover, nonuniformity is looked at by the color tone as compared with the light emitting diode of an example 1.
[0072] (Example 2) After the 4th process, except performing the 5th process which uses sheet expanded 10 for each light emitting diode, and forms the reflective film 11 in a silicon-on-sapphire side by the spatter, if light emitting diode is formed like an example 1, the same effect as an example 1 will be acquired. Moreover, the light of an end face can be taken out to a luminescence side good, and the light emitting diode of high power is obtained.
[0073] (Example 3) If light emitting diode is formed in each light emitting diode like an example 1 from a substrate side after the 4th process except forming the translucency mould member of fluorescent substance content in the circumference of a substrate Luminescence equipments other than the exposed surface of the bump prepared on the light emitting device which have the translucency mould member of the aforementioned fluorescent substance content on a periphery altogether are obtained. Since the same effect as an example 1 is acquired and also color conversion of the light which emits light from all directions of a light emitting device can be carried out good, color nonuniformity is suppressed and still more uniform luminescence is obtained.
[0074] On the other hand, 3aluminum5O12:Ce as a fluorescent substance (Y0.8Gd0.2) 80 weight sections, Mix ethanol by the weight of the double precision of the silanol (Si(OEt)3OH) 100 weight section and also the aforementioned silanol, and a slurry is formed. this slurry is breathed out from a nozzle to a wafer -- making -- the translucency mould of fluorescent substance content, after applying with the material of a

member It heats at 300 degrees C for 3 hours, and a silanol is set to SiO2, and except making a fluorescent substance fix on a wafer, if luminescence equipment is formed like an example 1, the same effect as an example 1 will be acquired.

[0075]

[Effect of the Invention] As explained in detail, the luminescence equipment concerning this invention can form a bump on each electrode, before cutting a wafer in the shape of a chip, piling of the conductive part can be carried out, and reliability can produce efficiently the color conversion type luminescence equipment which was highly excellent in the optical property by preparing a fluorescent substance content translucency mould member in a semiconductor layer side.

[0076] Moreover, since the luminescence equipment of this invention has the translucency mould member of fluorescent substance content on the whole circumference surface of a light emitting device by using a bump exposed surface as opening, it can transform the light from a light emitting device efficiently with a fluorescent substance, and can emit light uniformly in the color tone considered as a request. For this reason, degradation of the exterior by the light from a light emitting device can be suppressed.

[0077] Moreover, by preparing the insulating reflective film which followed the substrate side, optical ejection efficiency is good and can consider as the few luminescence equipment of luminescence nonuniformity.

[Translation done.]

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] the luminescence equipment characterized by providing the following -- it is -- the electrode top of the aforementioned light emitting device -- at least one bump -- having -- this bump's upper surface -- the aforementioned translucency mould -- the luminescence equipment which is the upper surface and the abbreviation same flat surface of a member The light emitting device which has a semiconductor layer on a substrate. The fluorescent substance with which a part of light from this light emitting device can be absorbed, and light can emit light rather than it in long wavelength. the translucency mould which has this fluorescent substance and surrounds the front face of the aforementioned light emitting device -- a member

[Claim 2] The aforementioned bump's thickness is luminescence equipment according to claim 1 which is 5 micrometers - 150 micrometers.
[Claim 3] the aforementioned bump's upper surface, and the aforementioned translucency mould -- luminescence equipment according to claim 1 to 2 with the upper surface of the luminescence equipment which consists of the upper surface of a member parallel to a substrate side base
[Claim 4] The aforementioned fluorescent substance is luminescence equipment according to claim 1 to 3 which is one sort chosen from nitrogen content CaO-aluminum2O3-SiO2 fluorescent substance activated by the yttrium aluminum garnet system fluorescent substance activated by Ce, Eu, and/or Cr.
[Claim 5] Luminescence equipment according to claim 1 to 4 which has the reflective film of the aforementioned light emitting device which followed the substrate side at least.
[Claim 6] The formation method of luminescence equipment of having the light emitting device which is characterized by providing the following and which has a semiconductor layer on a substrate, and the translucency mould member which absorbs a part of light from this light emitting device, has the fluorescent substance with which light can emit light and this fluorescent substance of long wavelength rather than it, and surrounds the front face of the aforementioned light emitting device. The 1st process which forms a bump on the electrode of the aforementioned light emitting device in the state of a wafer. The 2nd process which makes the material which serves as the aforementioned translucency mould member so that the aforementioned bump may be covered to the semiconductor layer side of the aforementioned light emitting device cover. The 3rd process which exposes a bump's upper surface to the aforementioned wafer base and parallel from a semiconductor layer side by polish. The 4th process which cuts the aforementioned wafer dicing and by carrying out a scribe.
[Claim 7] The formation method of the luminescence equipment according to claim 6 which forms the translucency mould member of the aforementioned light emitting device which followed the substrate side at least after the process of the above 4th.
[Claim 8] The formation method of the luminescence equipment according to claim 6 which forms the reflective film of the aforementioned light emitting device which followed the substrate side at least after the process of the above 4th.

[Translation done.]

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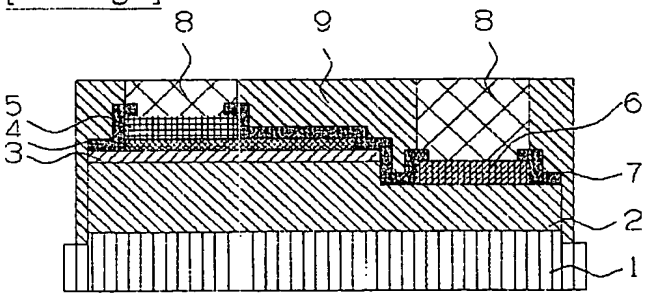
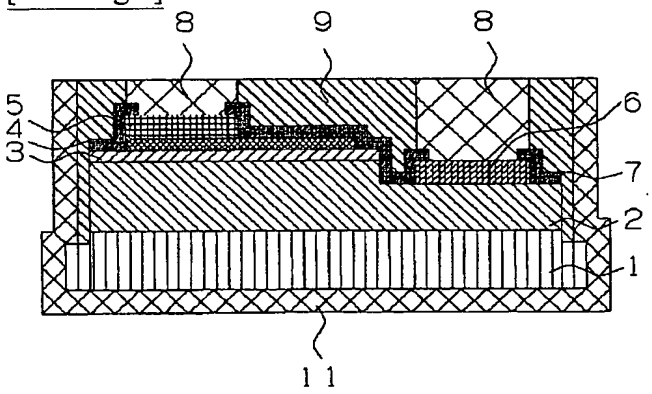
DRAWINGS

[Drawing 1]

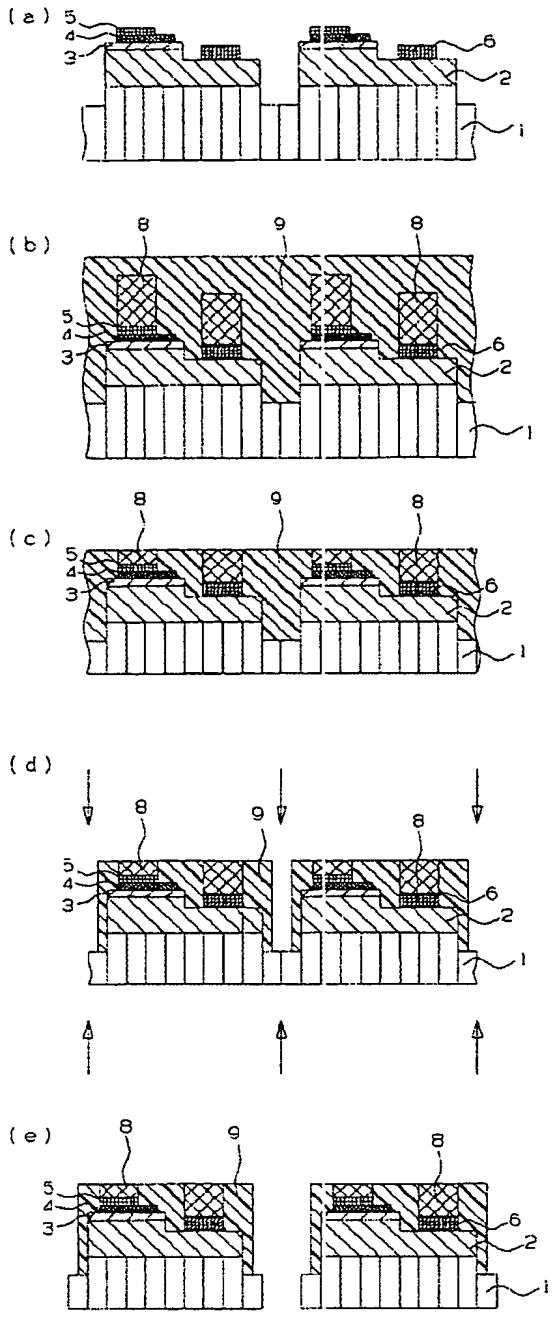


[Drawing 2]



[Drawing 3]

Fig 3



[Drawing 4]